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Research on Optimization and Classification of the Venture Capital Indexes in Financial Engineering

Jianqiao Lin, Dechun Huang, Jun Ren, Wenli Yuan[1*]

Hohai University, Nanjing 211100, P.R.China

Abstract

Venture capital, as one kind of investment instrument, has been highly concerned by investors and investment constructions. Combining the background of the development of risk investment industry, this paper introduces the gray clustering method to the optimization and classification for the risk investment indexes, thus establishing the model for those indexes based on the grey clustering method. Making optimization and classification analysis for the risk investment indexes coming from 10 companies, we found that the index optimization model is effective and practical, the research result can provide the risk investors important decision-making references.

Keywords: *optimization; classification; venture capital; complex system model; financial engineering*

1. Introduction

With the gradually prevailed for the venture capital in China, more and more people begin to understand the VC. In short, the investing procedure, in which people put capital to the research and development field for highly technology and products which contains failure risk, in order to encourage hi-tech achievement commercialization, industrialization and obtain high capital gains as soon as possible, is called venture capital. To specific understand the concept of venture capital we must first know the six factors of it. The venture capital is a kind of emerging companies' capital that grows rapidly and has great appreciation potential which is provided by professional investors. The venture capital enter the enterprise though the purchase, providing loans or taking two ways at the same time. The source for venture capital varies from state to state. Venture investors can be divided into: 1) venture capitalists. They invest to other entrepreneurs and the same as the other venture investors they make a profit though investment. But the difference is the capital which are invested by venture capitalists are all their own rather than the management of capital. 2) The venture capital company. There are many types for the venture capital company. But the most invest through venture-capital funds which generally are with the organized form of limited partnership. 3) The Industrial affiliated investment company. They are often the independent venture capital institutions which

1* Jianqiao Lin. Tel.: +860256851237;
E-mail address: jianqiaolin@163.com.

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subordinate some non financial industry company. They invest for the interests of parent company. This kind of investors mainly usual funds into some certain industries. The same as the traditional venture capital, Industrial affiliated investment company also evaluate the investment proposal submitted by financing company, due diligence into the company and look higher returns. 4) The angel investors. This kind of investors is usually investing into very young companies in order to help these companies start quickly. In the field of venture capital, the word "angel investors" refers to the first batch of investors for the entrepreneurs. These investors fund into the company before the products and business have shaped. Although it is a kind of equity investment, its purpose is not to get enterprise ownership, not to holding, even not for business. It aims at making the company big through investment and providing value-added services. And then through public listing, merger and acquisition or other means, the investors exit the company. They have realized their investment returns in the flow of the property. The main industry field for venture capital is high-tech industries. Take the United States for example, in 1992 the investment for computer and software occupied 27%.; The next is the healthcare industry, occupied 17%; The communication industry, occupied 14%; Biotechnology industry occupied 10%. Venture investors help enterprise to grow but they will ultimately seek channel to withdraw investment, in order to realize value-added. The length of time interval, which is from the venture capital funded into the invested company to the capital withdrawed from the company, is called the investment period. As a kind of equity investment, the period for venture capital is usually longer. Among them, the venture capital in stage will take 7-10 years to enter into maturity and the subsequent investment mostly only need a few years. Looking from the investment properties, there are three modes for venture capital: one is the direct investment. Two is to provide loans or guaranty fund. Three is to provide part of loans or guarantee funds and at the same time invest part of venture capital to purchase the equity of the invested enterprise. But whatever the investment mode is, the venture investors generally come to provide value-added services. Venture capital still has two different ways of entering. The first one is investing the venture capital partially into the invested enterprise by stages. This kind of circumstance is common. It can not only reduce investment risks, but also accelerate the capital turnover; The second one is one-time investment. This way is not common, which is often taken by venture capitalists and angel investors. After once investing they are not willing to provide follow-up financing.

2. Research literature review for venture capital and decision-making flowchart

At present, the tide for venture capital is still growing worldwide. The venture capital, with its high yield, high risk, high technology and high growth potential, is highly concerned by investment institutions and individual investor. It shows strong vitality. In the process of recovering from the worldwide financial crisis, venture capital takes an important role. The related researches for venture capital were reviewed following. Currently, with the development of mathematical theory and information technology, more and more scholars begin to use the method of quantitative to research on venture capital. For venture capital decision-making model provides a scientific method of quantitative analysis. It is the developed direction of scientific decision for introducing the mathematical method of quantitative analysis and computer simulation technology to decision analysis of the venture capital. In the paper' The Research On The Application Of Multi-objective Decision-making Model In The Venture capital', the author analyzed the application of multi-objective decision-making mode of operations in the risk assessment of the venture capital project, and discussed about the application of American risk evaluation technology-VERT. In the paper author emphasized using the scientific quantitative analysis to assess investment risk, thus providing basis for making scientific and correct investment decision. Meantime he emphasized the importance of using the advanced computer simulation technology to quantize the investment risk and investment gains. [1]

On the basis of the analysis and summary for the foreign venture investors' documents about investment decision-making process, the paper ' Study on the Model of Investment Decision Process of Venture Capitalist' combines the actual situation of our country and the developing status of venture capital in our country ,and puts forward a set of general investment criteria and the investment decision-making process model of venture capitalists which are suitable for our country's venture capital practice. In the paper author constructed the table of risk investment decision factors and built the model of risk investment decision-making process which is suitable for our country's situation. It has certain directive significance for our country's venture capital practice. [2]

Above we mentioned risk investment is mostly in some high-tech fields, so IT must be the hottest industry for venture capital. In the paper 'Study on the Model of Venture capital Decision-making on the Basis of Software Project AHP', through analyzing the main factors affecting the venture capital in software project, author

constructed an evaluation index system, containing the characteristics of software project and venture capital, for project venture capital. And author optimized venture capital plan of software project on the base of AHP. Thus he realized the objective that providing references for risk investment decision-making of software project and reducing the errors of venture capital decision-making. [3]

Also providing decision-making support for venture capital project, the paper 'Decision-making in Venture Capital Investment Based on Fuzzy Simulation' described the earnings of venture capital project and state probability as fuzzy variables, constructed the model of fuzzy risk investment decision-making by using the mean and variance of fuzzy variables, and gave the examples of calculating by the method of fuzzy simulation. [4]

Through the analysis of the venture capital decision-making process, this paper constructed the flow chart of venture capital. The flow chart reflects the factors which should be taken into account during the process of venture capital decision-making. That gives the support for constructing the following decision-making index of venture capital.

3. The Application of Venture capital indexes optimization model based on the grey clustering

The decision-making index selection of the venture capital company is different from other decision-making index selection, but from the purpose and the method they are similar. The principle for selection is discovering the economic benefit and development potential of the company from these indexes. From the aspects of the company' performances, we can get much about the company's benefit indexes which together constitute the index system. An effective indicator system should neither miss any important indexes nor contain extra indexes. Besides, the index should be difference from each other. The indexes in the indicator system should provide reliable information for the company' scientific development and provide powerful support for the investment decision-making. In short the index system should obey the following principle: profitability, comprehensive, systematic, orientation, stability, unity, practicality, comparability.

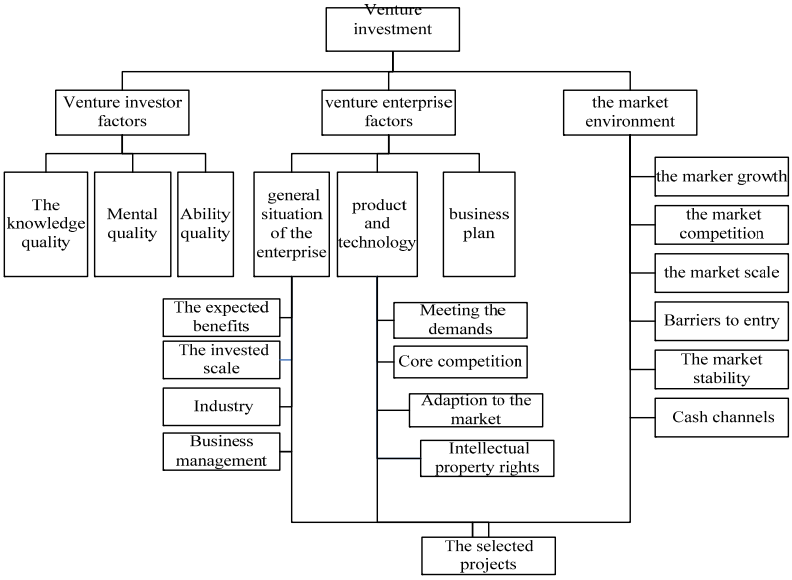

Fig.1 Process of decision-making on the venture capital

4. The application of the venture capital index optimization model based on the gray clustering

4.1 Characteristic data

According to the gray clustering analysis, there are 10(m=10) objectives and every objective contains 10(n=10)

characteristic data. The sequence is as follows:

$$X_1 = \{x_1(1), x_1(2), ..., x_1(m)\}$$

$$X_2 = \{x_2(1), x_2(2), ..., x_2(m)\}$$

$$\cdots$$

$$X_n = \{x_n(1), x_n(2), ..., x_n(m)\}$$

Table 1 the original data comes from 10 companies in 2010

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
Y1	0.17	0.15	0.29	0.24	0.46	0.18	0.18	0.42	0.40	0.30
Y2	0.19	-0.75	-0.96	0.13	0.42	0.39	0.02	0.35	-0.12	-0.23
Y3	0.2	0.17	0.11	0.27	0.42	0.37	0.24	0.29	0.27	0.32
Y4	0.39	0.26	0.16	0.53	0.31	0.50	0.21	0.10	0.38	0.31
Y5	0.41	0.19	0.08	0.41	0.31	0.23	0.16	0.17	0.29	0.37
Y6	0.48	0.41	0.14	0.31	0.20	0.17	0.59	0.09	0.25	0.22
Y7	0.14	0.29	0.12	0.28	0.15	0.12	0.40	0.51	0.32	0.29
Y8	0.11	0.12	0.11	0.28	0.37	0.25	0.44	0.35	0.41	0.38
Y9	0.56	0.12	0.05	0.26	0.13	0.48	0.08	0.18	0.13	0.31
Y10	0.13	0.04	0.59	0.25	0.3	0.13	0.31	0.36	0.37	0.36

Calculate the gray relation degree ξ_{ij} between X_i and X_j, setting a marginal value Γ, which makes $0 < \Gamma \le 1$ and requires $\Gamma > 0.5$. When $\xi_{ij} \ge \Gamma$, we treat X_i and X_j on the same level and the same character. As the result, we get the character ($X_1, X_2, ... X_n$) on the same level and belongs to the same class. Additionally, the marginal value Γ can be modified according to the practical requirement. What is needed to be added is that as for the Γ the closer to 1, the more subdivide the result is.

4.2 Normalization

Because the data are different character index, in order to make these data comparable, we normalize the data firstly. Here we adopt the average value method to initialize these data, the formula is as follows:

$$x_n = \{\frac{x_n(1)}{\sqrt{\sum_k [x_n(k)^2]}}, \frac{x_n(2)}{\sqrt{\sum_k [x_n(k)^2]}}, ... \frac{x_n(m)}{\sqrt{\sum_k [x_n(k)^2]}}\}$$

After the disposition of the data , the result is reflected in the following table.

Table 2 The initialized data

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
Y1	14.51	4.55	25.66	93.23	85.58	0.66	5.63	6.32	48.56	46.84
Y2	16.71	-22.14	-85.33	51.25	78.45	1.44	0.47	5.21	-15.23	-35.78
Y3	17.21	5.12	10.25	105.55	35.36	1.36	7.66	4.32	32.36	49.58
Y4	33.55	7.56	14.36	204.23	57.36	1.85	6.68	1.55	45.62	48.57
Y5	35.48	5.69	7.26	156.77	58.55	0.85	5.08	2.62	35.26	57.25
Y6	41.26	12.23	12.35	118.23	38.35	0.62	18.5	1.36	30.56	34.25
Y7	12.26	8.65	10.88	109.25	28.25	0.47	12.56	7.56	38.23	45.77
Y8	9.14	3.6	10.25	108.36	68.25	0.94	13.87	5.25	49.56	58.62
Y9	48.25	3.45	4.36	100.36	25.25	1.75	2.56	2.69	15.47	48.23
Y10	11.47	1.3	5.25	95.25	67.99	0.48	9.65	5.36	44.84	56.45

4.3Annihilation

After the normalization of the original data, we dispose the Xi to realize annihilation X(0)I. The calculating process is as follows:

$X_0^{(0)}(k) = X_0(k) - X_0(1)$, $X_1^{(0)}(k) = X_1(k) - X_1(1)$, $k = 1, 2, ..., m$,

The result of annihilation is in table 3 as follows.

Table 3 The result of annihilation of the decision index

X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
0.02	-0.9	-1.25	-0.11	-0.04	0.21	-0.16	-0.07	-0.52	-0.53
0.03	0.02	-0.18	0.03	-0.04	0.19	0.06	-0.13	-0.13	0.02
0.22	0.11	-0.13	0.29	-0.15	0.32	0.03	-0.31	-0.02	0.01
0.24	0.04	-0.21	0.17	-0.15	0.05	-0.02	-0.25	-0.11	0.07
0.31	0.26	-0.15	0.07	-0.26	-0.01	0.41	-0.33	-0.15	-0.08
-0.03	0.14	-0.17	0.04	-0.31	-0.06	0.22	0.03	-0.08	-0.01
-0.06	-0.03	-0.18	0.04	-0.09	0.07	0.26	-0.07	0.01	0.08
0.39	-0.03	-0.24	0.02	-0.33	0.3	-0.1	-0.24	-0.27	0.01
-0.04	-0.06	0.3	0.01	-0.16	-0.05	0.13	-0.06	-0.03	0.06

4.4 Calculate the gray relation degree

To make $S_0 = \sum_{k=2}^{m-1} x_0^{(0)}(k) + \frac{1}{2} x_0^{(0)}(m)$ $S_1 = \sum_{k=2}^{m-1} x_1^{(0)}(k) + \frac{1}{2} x_1^{(0)}(m)$, calculate the decision index S and $|S|$. The gray relation degree formula is as follows: $\xi = \frac{1 + |S_0| + |S_1|}{1 + |S_0| + |S_1| + |S_1 - S_0|}$.

The calculating results based on the formula is in the table 4.

Table 4 The gray relation degree of the data

	$X_1^{(0)}$	$X_2^{(0)}$	$X_3^{(0)}$	$X_4^{(0)}$	$X_5^{(0)}$	$X_6^{(0)}$	$X_7^{(0)}$	$X_8^{(0)}$	$X_9^{(0)}$	$X_{10}^{(0)}$
X1	1	0.62	0.58	0.85	0.58	0.98	0.9	0.58	0.59	0.63
X2		1	0.74	0.66	0.61	0.63	0.67	0.61	0.61	0.99
X3			1	0.6	0.98	0.71	0.6	0.99	0.98	0.74
X4				1	0.6	0.84	0.92	0.6	0.61	0.67
X5					1	0.58	0.59	0.99	0.96	0.73
X6						1	0.91	0.58	0.62	0.63
X7							1	0.59	0.6	0.65
X8								1	0.97	0.97
X9									1	0.75
X10										1

4.5 The process and the result analysis

According to the process above, we conclude the step of this method and make an flow-process diagram which is as follows.

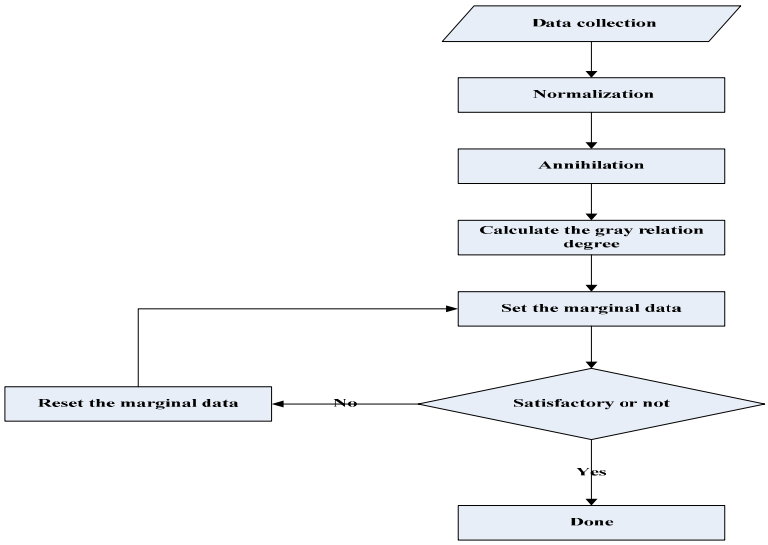

Fig.2 Process of analysis of the index

According to the data in the table 4, we can classify the index. To set the marginal value is 0.8. The index can be classified into 3 categories which are $\{X_1, X_4, X_6, X_7\}, \{X_2, X_{10}\}, \{X_3, X_5, X_8, X_9\}$.

We figure out that the first class index contains R&D ability, intellectual property right, competing advantage, imitable, the second class index includes market volume, demand fluctuate, the third class index contains operation benefit, financing ability, earning ability and investment return.

After the qualitative and the quantitative analysis, we construct and optimize the index system. The optimized index system is as follows in table 5 and table 6.

Table 5 The investment decision system of venture capital

The first class index	Technical index			
The second class index	R&D ability	intellectual property right	competing advantage	imitable

Table 6 The investment decision system of venture capital

The first class index	Market and government index		Financial index			
The second class index	market volume	demand fluctuate,	operation benefit	financing ability	earning ability	investment return.

5. Conclusion

Venture capital offer the investors at home and abroad a high-risk but rich return investment tool. Before making decision to step into this areas, the investor must take account of the substantial risk factors and possible return comprehensive. The paper do a research on the decision index of the venture capital based on an integrated qualitative analysis and the gray clustering model to realize the classification of the index system. Through the empirical analysis, it reflects the importance of this method on the research of the index system of the venture capital and it proofs that this model supply the investors an efficient way to make decision before the formal investment conduction.

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